
AT4-CS Final Update



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Project goal is to demonstrate viability of ALE3D for simulating AT4-CS performance

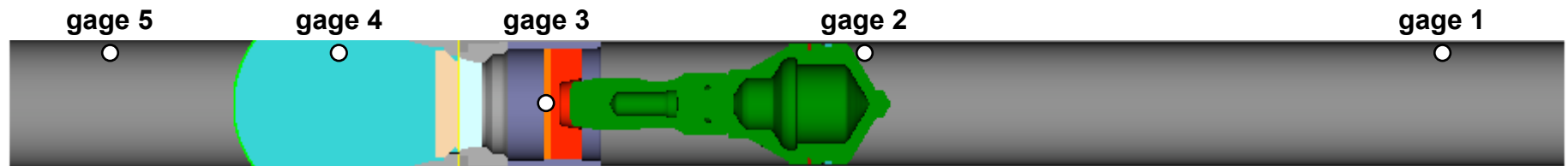


- **Primary deliverables are comparisons of experimental and simulated propellant chamber pressure and projectile exit velocity**
- **Experimental design went through various iterations**
 - **finalized geometry for simulation during mid-April LLNL onsite visit at Benét**
- **2D simulation constructed from 3D CAD model and updated data**
- **JWL igniter/propellant equations-of-state constructed**
- **Shakedown calculations performed**



Full-view of 2D simulation geometry

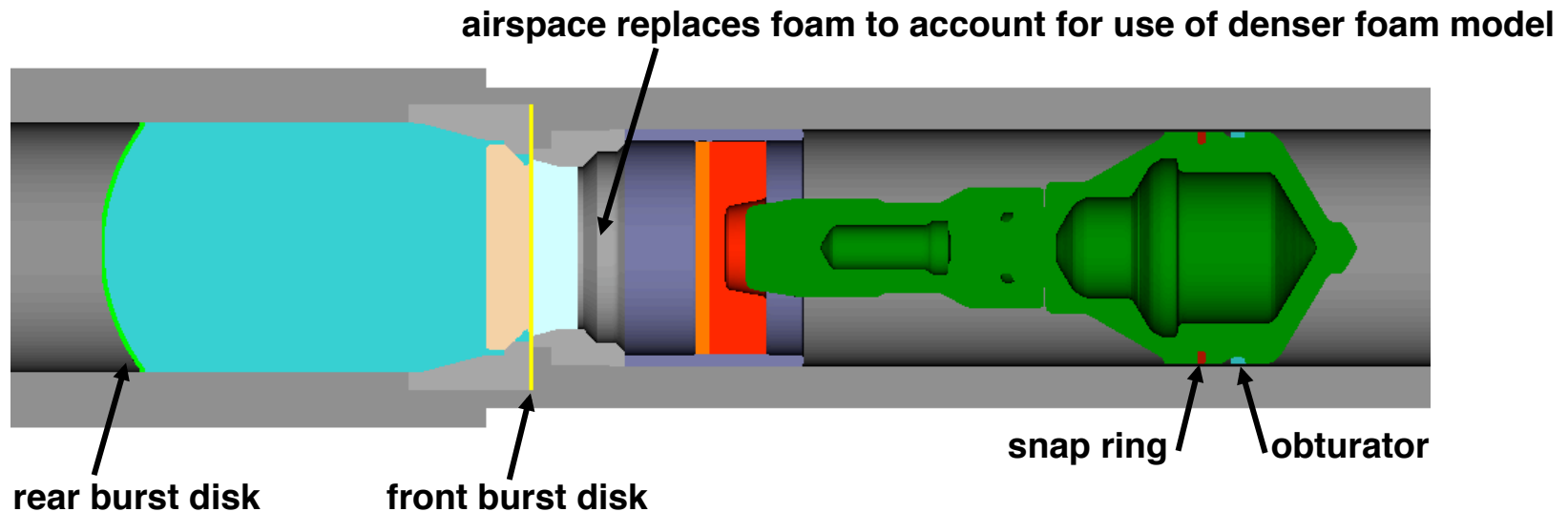
- Simulation details (40K zones, 32 cpu, 4000 s → simulate to 4 ms)
 - projectile: 1.96 kg ; contains hollow regions
 - countermass: 0.9 kg
 - cardboard propellant chamber
 - Red Dot igniter: 20 gm, 0.875 g/cc
 - M38 propellant: 87 gm, 1.096 g/cc
 - all non-solid regions filled with air
 - slideline along entire length of tube interior including nozzle
 - 5 pressure gages





Expanded view of 2D simulation geometry

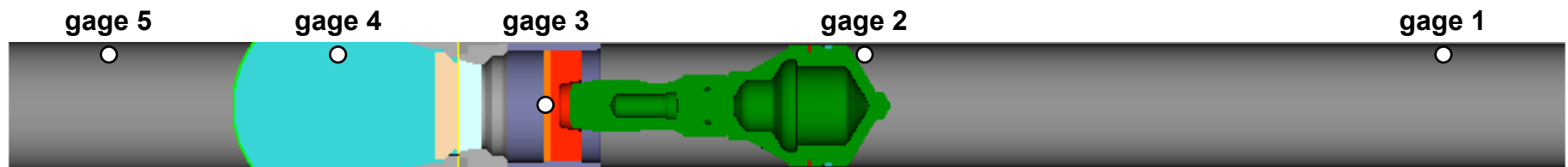
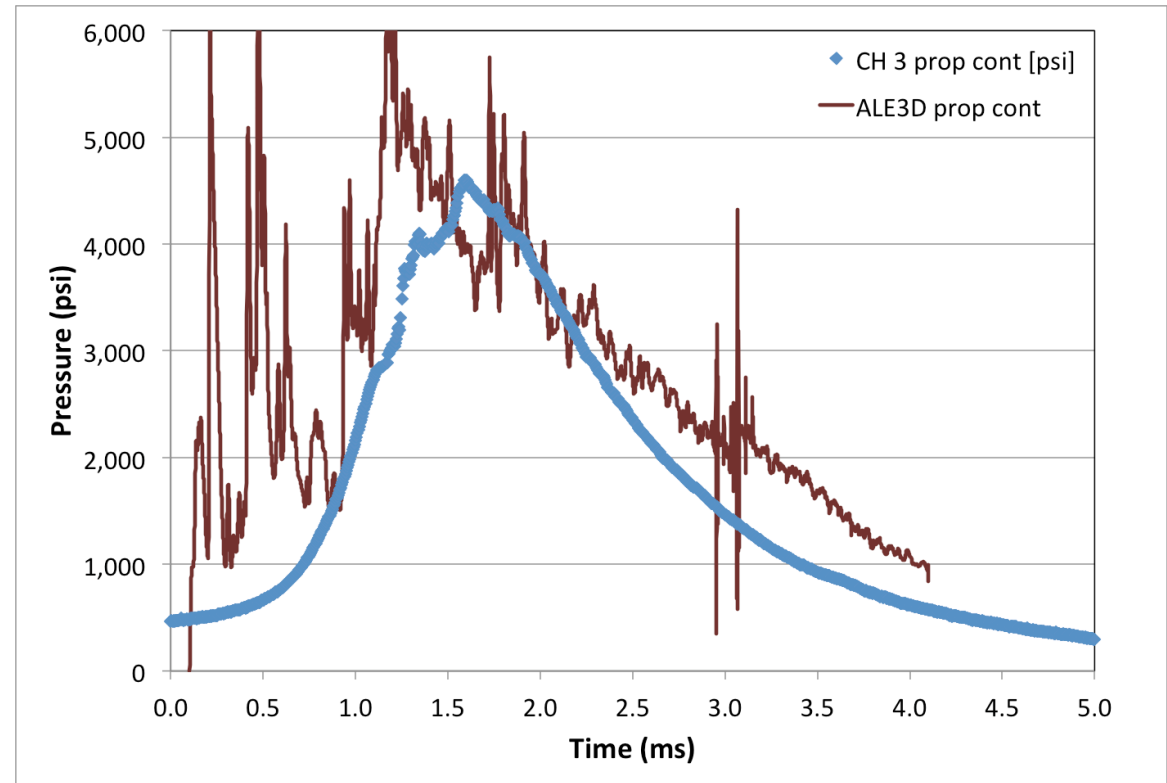
- Simulation details
 - EPDM: 0.09 g/cc
 - LD45: 0.038 g/cc simulated using 0.09 g/cc foam in less volume, to preserve mass
 - snap ring and burst disk failure criteria based on time not pressure
 - snap ring @ 750 μ s
 - first burst disk @ 600 μ s
 - rear burst disk @ 750 μ s



Propellant chamber [deliverable 1 of 2] [gage 3] experiment and simulation



- Simulation “spikes” before 2 ms are due to shock reflections resulting from propellant burn model

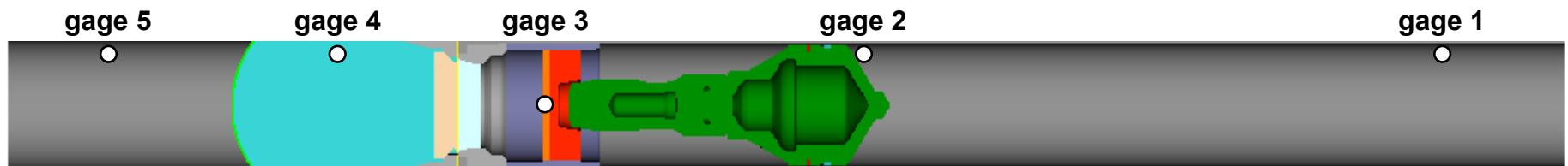
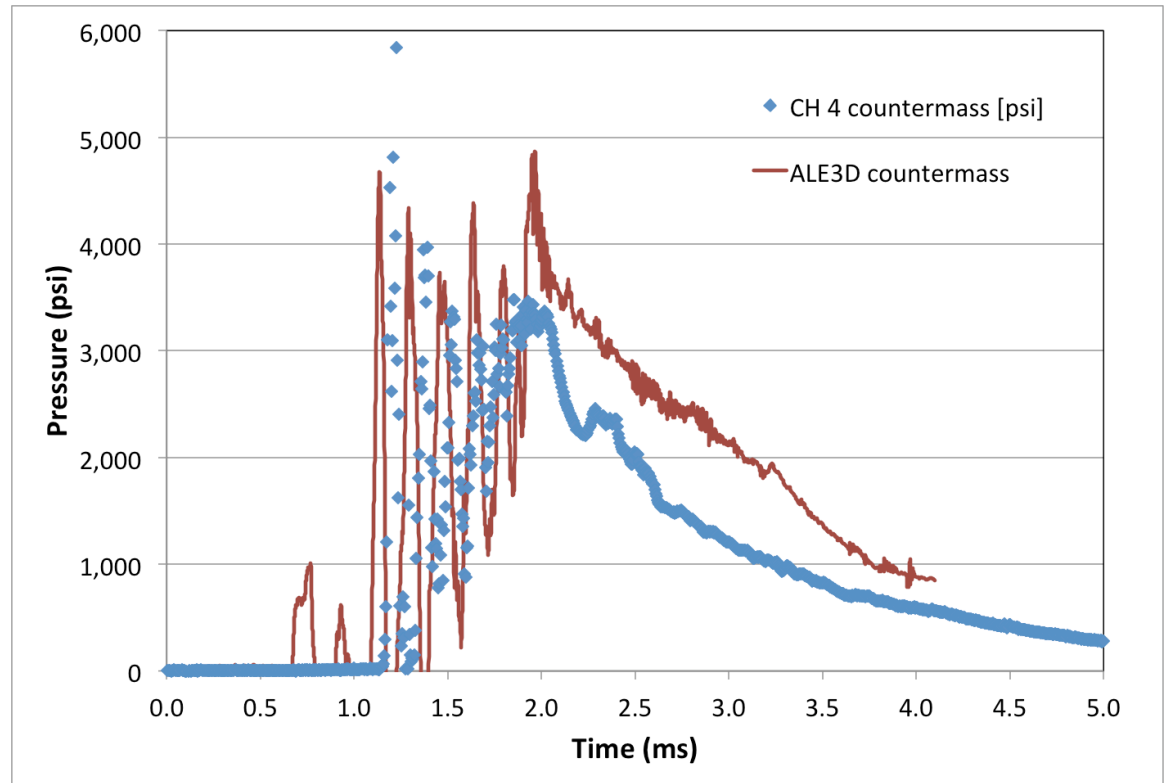


Countermass

[gage 4] experiment and simulation



- **Simulation
pulsewidth and
structure compare
favorably with
experimental data**

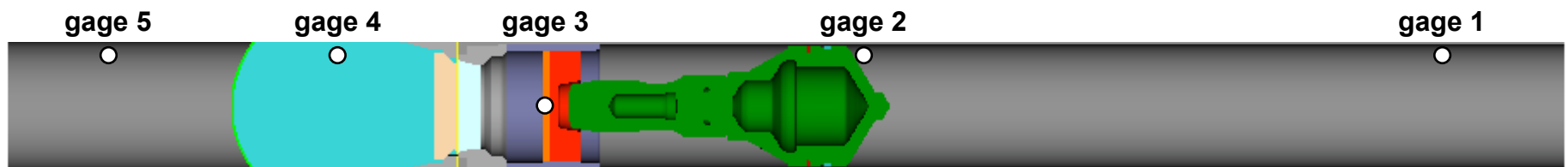
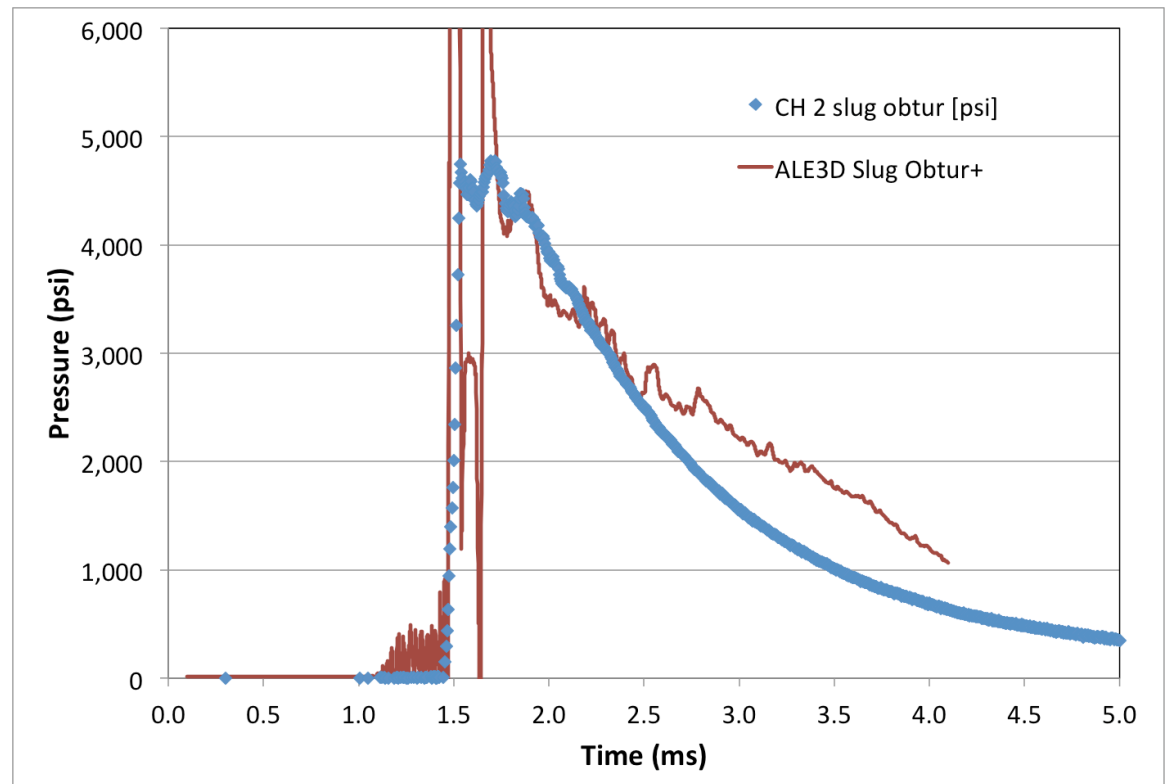


Obturator

[gage 2] experiment and simulation



- **Simulation peak and pulsewidth compare favorably with experimental data**

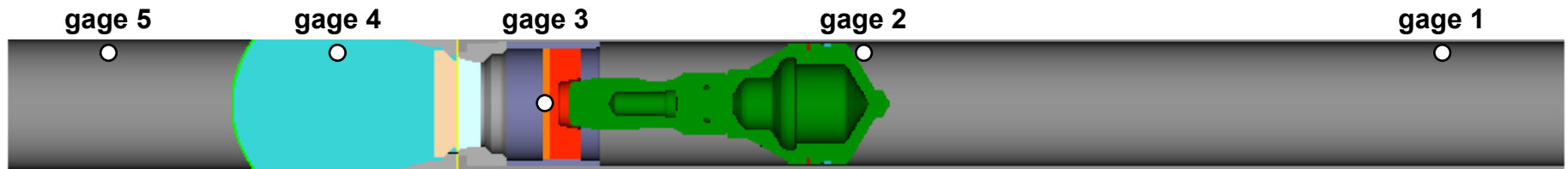
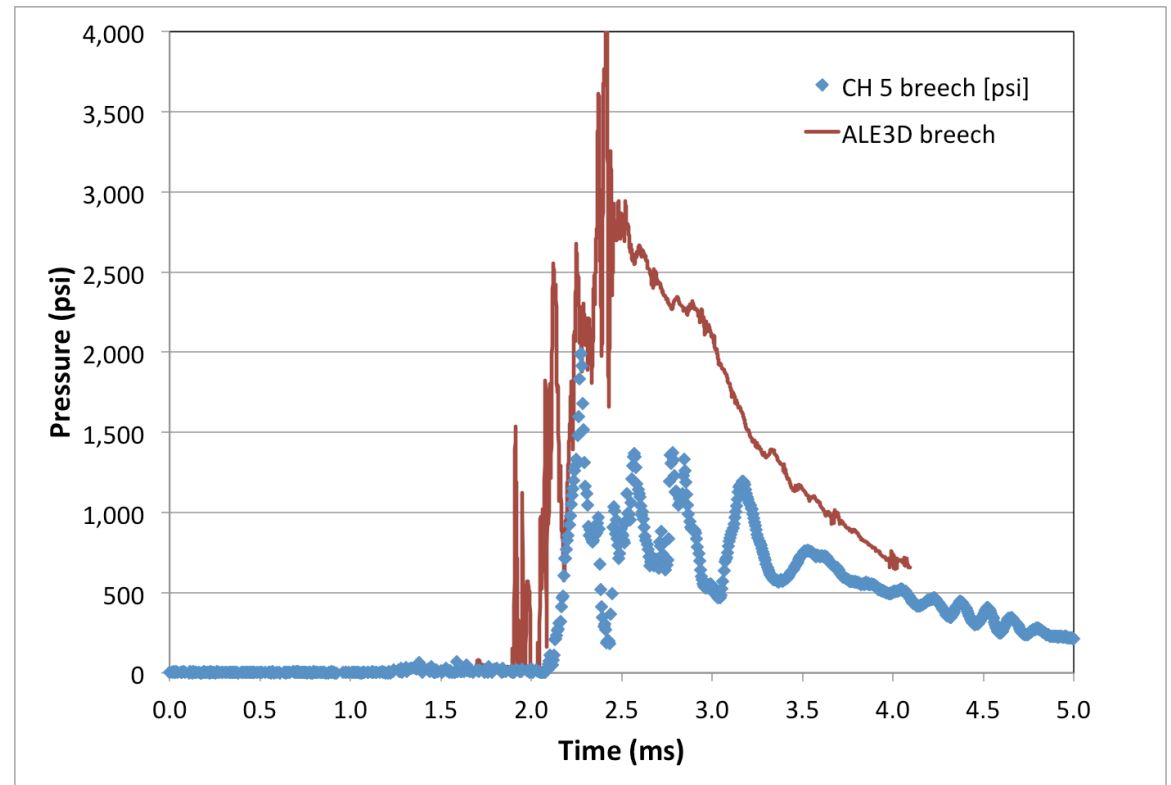


Breach

[gage 5] experiment and simulation



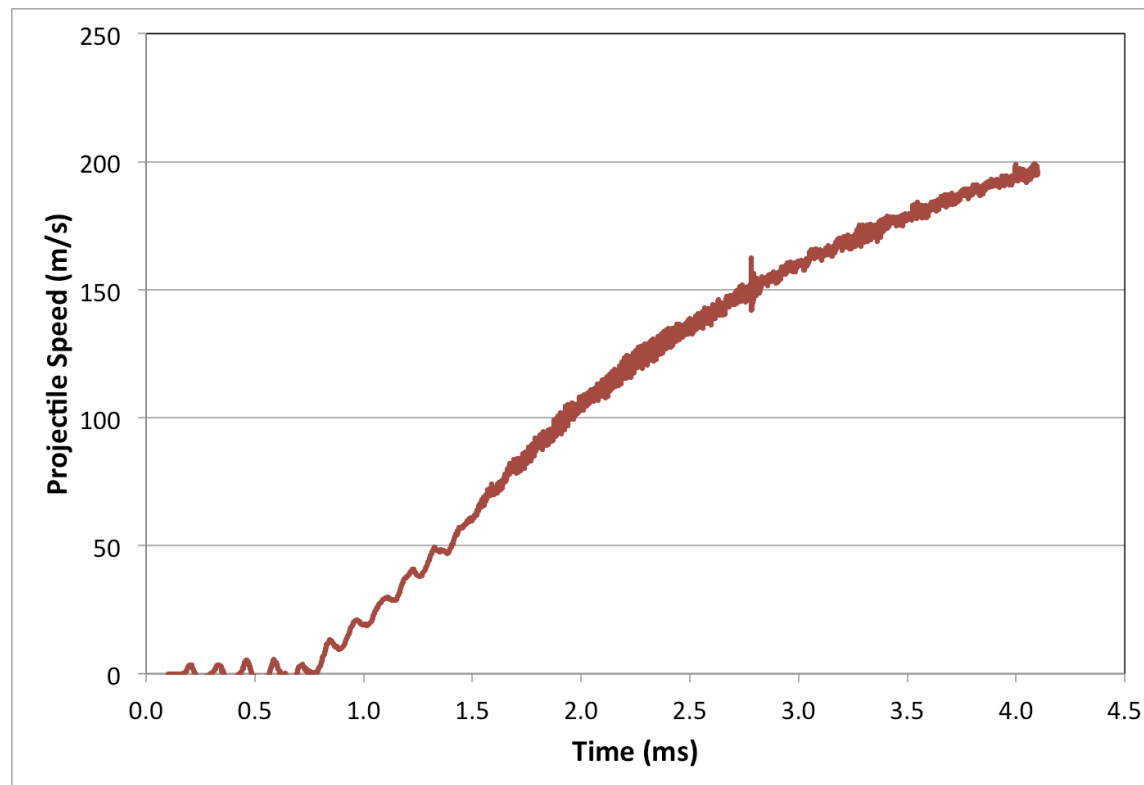
- Simulation peak pressure is too high
- Differences are probably due to details of front burst disk failure, which are beyond the scope of this project
- **Consequently, we expect overpredictions at external blast overpressure gages**



Projectile speed [deliverable 2 of 2] experiment and simulation



- Simulated exit velocity ($\sim 200\text{m/s}$) compares favorably to $\sim 180\text{m/s}$ experimental velocity
 - experimental time-dependent projectile velocity not measured
 - experimental projectile exit velocity estimated from data





Summary

- **Simulated projectile speed and propellant chamber pressure agree sufficiently well with data to demonstrate the viability of using ALE3D to simulate the AT4-CS**
- **Detailed spatial and temporal modeling of the burst disk failure will be required to accurately model the countermass response and subsequent overpressures at Soldier locations around the AT4-CS**